SOLAR PHYSICS

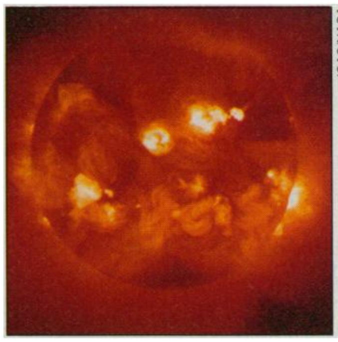
Dim Corona Foreshadows Storms

Magnetic storms don't darken the sky or rattle the windows, but their impact is unmistakable. Gusts of solar wind, the thin plasma that blows out from the sun, shake Earth's magnetic field and pump charged particles into the radiation belts surrounding the planet. The tumult can set off radiation alarms aboard aircraft, induce damaging currents that surge through power grids on the ground, and cause Earth's atmosphere to swell, knocking satellites out of orbit. These storms often erupt with little advance warning, but last month researchers announced they may be a step closer to predicting them.

A team led by Loren Acton of Montana State University reported that observations from the U.S.–Japan Soft X-ray Telescope aboard Japan's Yohkoh spacecraft showed that the corona, the sun's million-degree atmosphere, dims at the same time as vast bubbles of plasma erupt from it. Because the arrival of a plasma bubble at Earth's magnetic field triggers a magnetic storm 2 or 3 days later, detecting the dimming could provide at least 50 hours' warning of the impact. That would allow power companies to prepare for the expected surges by switching on devices that block currents, and satellite operators to take steps to protect their spacecraft.

Hugh Hudson, an astronomer at the University of Hawaii, notes that accurate predictions based on the dimming are still a long way off. "This result is brand new and not well calibrated yet," says Hudson. But it is the first hint of a way to detect menacing plasma eruptions early in their journey. Ground-based coronagraphs can reveal plasma ejections only when they burst from the edge of the sun, away from Earth. As a result, magnetic storm forecasters have to watch for solar flares, which often accompany the eruption of mass ejections, and rely on measurements from WIND, a satellite that directly measures the solar wind from a vantage just upwind of Earth. When both false alarms and "blind-siding" are considered, current long-range predictions have an accuracy of only 30%, says John Kappenman, head of the transmission power engineering group at Minnesota Power. And WIND gives only 30 to 60 minutes' warning of impending storms.

Solar physicists have always thought that a coronal mass ejection must leave behind a void, simply because of the huge volume—17,000 times that of Earth—that escapes. But nobody noticed such voids until late 1994, when Hudson and astronomer James Lemen of the Lockheed-Martin Solar and Astrophysics Laboratory examined a series of Yohkoh images of a 1992 coronal mass ejection and spotted the dim region left behind. "The discovery was accidental," says Hudson. "We have had Yohkoh up there for 4 years. It was embarrassing that we didn't notice this earlier." But after the researchers had made the link, they began to see voids routinely.



ISAS/NASA

Stormy sun. Wispy arches *(upper right)* trace a plasma ejection.

In the future, say Kappenman and Hudson, an x-ray satellite watching the sun could detect the telltale dimmings, which could be converted into storm warnings for the benefit of utilities and satellite operators. But Hudson and his colleagues caution that the dimming is difficult to observe and can't be seen every time plasma escapes. In addition, only one of every six strong solar gusts that reach Earth's magnetic field triggers a major storm, says Bruce Tsurutani, a senior research scientist at the Jet Propulsion Laboratory in Pasadena, California. He explains that the orientation of the magnetic field within the puff of solar wind affects its ability to deposit energy in Earth's magnetic field.

Kappenman, however, thinks that further analysis of the dimmings and the solar wind's magnetic field could open the way to predictions with nearly 100% accuracy. He and his colleagues are now pinning their hopes on data from spacecraft such as the European Solar and Heliospheric Observatory (SOHO), launched last December, which recently took pictures of the sun ejecting plasma over a 5-hour span. "We're taking the first tentative steps to coordinating all of this research," says Keith T. Strong, manager of the Lockheed-Martin laboratory. "We're starting to get the big picture" of space weather.

–Kim Peterson

HEAVY–ION PHYSICS

GSI Bags Another New Element

BERLIN—Germany's GSI Heavy-Ion Research Center in Darmstadt confirmed its position as the world leader in forging new elements last week when it announced the creation of element 112. The element, the heaviest ever observed, is GSI's sixth new element in a row since 1981 and its third in less than 18 months (*Science*, 2 December 1994, p. 1479).

Members of the dozen-strong international team at GSI, led by Peter Armbruster, say it took 2 weeks of effort to create the single atom of element 112 they detected on the evening of 9 February. Using the laboratory's UNILAC heavy-ion accelerator, the researchers bombarded a lead target with billions of high-energy zinc ions in an attempt to fuse the two different nuclei. By passing the debris through a magnetic field, a detector beyond the target sorted it by mass and spotted the new element. The new nucleus decayed in less than a microsecond, but its decay chain—which the researchers followed through five daughter isotopes as they emitted alpha particles (helium nuclei)—confirmed its identity.

Along the way, the nucleus helped verify theoretical models of the nucleus. Theorists believe that protons and neutrons in the nucleus arrange themselves in "shells," and that full shells confer extra stability. The isotope of element 112 that the GSI team has created has 165 neutrons, not enough to fill out its outermost shell. But as it decays into lighter nuclei, it passes through a phase with 162 neutrons—just enough, according to theory, to fill a "deformed" shell that confers some extra stability.

By studying the decay chain of element 112 as the number of neutrons passes 162, the GSI team was able to confirm that the deformed shell is more stable. GSI researchers said in a statement: "The decay chain, which demonstrates the stabilization at 162 neutrons, confirms the predictive power of the theoretical model of nuclear structure."

Fritz Peter Hessberger, a member of the GSI team, says the group's next goal is to create an isotope of element 113. The Holy Grail of such experiments, however, is an isotope of element 114 with spherical shells of both protons and neutrons. It and similar isotopes around it are predicted to have much greater stability than other superheavy elements, but Hessberger says such theories "can only be clarified by future experiments."

Hessberger says the GSI scientists "are not even discussing a name now" for element 112 because of the unsettled issue of names for some superheavy elements. Priority disputes over the discovery of earlier elements by Russian and U.S. groups had spawned multiple names. The International Union of Pure and Applied Chemistry (IUPAC) settled the dispute over discovery, but then angered the research community by ignoring some names chosen by the discoverers and choosing new names. IUPAC was due to confirm its choice of names last summer, but backed down at the last minute after a storm of protests, and the matter remains unresolved.

–Robert Koenig

Robert Koenig is a writer in Berlin.